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Chapter 1
Science for Loss and Damage. Findings and Propositions

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Abstract The debate on "Loss and Damage" (L&D) has gained traction over the last few years. Supported by growing scientific evidence of anthropogenic climate change amplifying frequency, intensity and duration of climate-related hazards as well as observed increases in climate-related impacts and risks in many regions, the

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"Warsaw International Mechanism for Loss and Damage" was established in 2013 and further supported through the Paris Agreement in 2015. Despite advances, the debate currently is broad, diffuse and somewhat confusing, while concepts, methods and tools, as well as directions for policy remain vague and often contested. This book, a joint effort of the Loss and Damage Network—a partnership effort by scientists and practitioners from around the globe—provides evidence-based insight into the L&D discourse by highlighting state-of-the-art research conducted across multiple disciplines, by showcasing applications in practice and by providing insight into policy contexts and salient policy options. This introductory chapter summarises key findings of the twenty-two book chapters in terms of five propositions. These propositions, each building on relevant findings linked to forward-looking suggestions for research, policy and practice, reflect the architecture of the book, whose sections proceed from setting the stage to critical issues, followed by a section on methods and tools, to chapters that provide geographic perspectives, and finally to a section that identifies potential policy options. The propositions comprise (1) Risk management can be an effective entry point for aligning perspectives and debates, if framed comprehensively, coupled with climate justice considerations and linked to established risk management and adaptation practice; (2) Attribution science is advancing rapidly and fundamental to informing actions to minimise, avert, and address losses and damages; (3) Climate change research, in addition to identifying physical/hard limits to adaptation, needs to more systematically examine soft limits to adaptation, for which we find some evidence across several geographies globally; (4) Climate risk insurance mechanisms can serve the prevention and cure aspects emphasised in the L&D debate but solidarity and accountability aspects need further attention, for which we find tentative indication in applications around the world; (5) Policy deliberations may need to overcome the perception that L&D constitutes a win-lose negotiation "game" by developing a more inclusive narrative that highlights collective ambition for tackling risks, mutual benefits and the role of transformation.

Keywords Science · Policy · Practice · Climate justice · Limits to adaptation Climate risk management · Transformation

1.1 Understanding and Reviewing the Evidence for Advancing Science and Policy

The debate on Loss and Damage (L&D)[1] has gained traction over the last few years. Although the discourse started already during the establishment of the United Nations Framework Convention on Climate Change (UNFCCC) in the early 1990s with a proposal by the Alliance of Small Island States (AOSIS) on compensation and

[1] In this chapter and in the book throughout, we will use the plural form and lowercase letters ('losses and damages') to refer broadly to (observed) impacts and (projected) risks, and the capitalized singular form ('Loss & Damage') where reference is made to the policy debate.

insurance for losses due to sea-level rise (INC 1991), it took about 20 years, alongside increasing evidence and public awareness of climate change impacts and risks as collated prominently in reports by the Intergovernmental Panel on Climate Change (IPCC), for it to be recognised at the institutional level. In 2007 UNFCCC's 13th Conference of the Parties (COP 13) in Bali first broadly considered means to address Loss and Damage, yet only in 2012 at COP 18 in Doha did Parties for the first time decide to consider institutional arrangements to address L&D, which in 2013 led negotiators at COP 19 to establish the "Warsaw International Mechanism for Loss and Damage associated with Climate Change Impacts" (WIM) (UNFCCC 2013). In 2015 at COP 21, the Paris Agreement established a separate article on L&D endorsing the Mechanism (UN 2015) (see Fig. 1.1). Since its establishment, the WIM, whose Executive Committee has devised work programmes to inform the deliberations, has been subject to intense debate. While some consider it a distinct building block of negotiations under the UNFCCC alongside mitigation and adaptation, others suggest that it is supposed to be an integral part of the negotiations under climate change adaptation. The implications and final directions for this Mechanism, which will undergo review in 2019, are, however, largely unclear.

The debate currently is broad, diffuse and somewhat confusing, while concepts, methods and tools, as well as directions for policy remain vague and contested. Over the last few years, research has been requested to provide actionable input and has increasingly become active. Scholarship has started to provide evidence on losses and damages in vulnerable countries (Warner and van der Geest 2013), coined and critically examined definitions, the rationale and plural perspectives on the discourse (Verheyen and Roderick 2008; James et al. 2015; Van der Geest and Warner 2015; Vanhala and Hestbaek 2016; Boyd et al. 2017), employed applicable methods and models (Gall 2015; Birkmann and Welle 2015; Schinko and Mechler 2017), reviewed roles for justice and equity considerations (Huggel et al. 2016a; Roser et al. 2015; Wallimann-Helmer 2015), spent due attention on non-economic losses (Serdeczny et al. 2017; Tschakert et al. 2017; Wewerinke-Singh 2018a), supported crafting of policy and governance options (Pinninti 2013; Page and Heyward 2017; Mechler and Schinko 2016; Crosland et al. 2016; Biermann and Boas 2017) and examined the role of legal responses to L&D (Mace and Verheyen 2016; Mayer 2016; Wewerinke-Singh 2018b).

Many gaps remain, not the least in terms of communication across the science-policy interface. Analysts and observers, including the authors of this book, have argued that these gaps have hampered understanding and progress towards effective policy formulation, as well as practical implementation. As we demonstrate in this book, a more strongly evidence-based dialogue is desirable and feasible, and we see a number of promising options for instilling more coherence into the debate and foster alignment with other policy agendas, particularly with regard to climate change adaptation (CCA), current international efforts on disaster risk reduction (DRR), as well as the United Nations Sustainable Development Goals (SDGs).

This book thus aims at providing insights into the L&D discourse by highlighting state-of-the-art research from multiple disciplines as well as policy contexts related to L&D. It articulates the multiple concepts, principles and methods relevant for L&D,

Fig. 1.1 Evolution of the Loss and Damage discourse under the UNFCCC. *Source* UNFCCC (2018)

including those that have only recently become available. As such, this volume is the first comprehensive outcome of the Loss and Damage Network, a partnership effort by scientists and practitioners, which includes members from more than 40 institutions around the globe. Aimed at informing research, policy, practice and the interested public, this book:

- discusses the political, legal, economic and institutional dimensions of L&D,
- introduces normative and ethical questions central to the discourse,
- highlights the role of climate risks and climate risk management,
- presents salient case studies from around the world,
- identifies practical and evidence-based policy and implementation options, and thus
- supports the science-policy dialogue and possible future directions of the L&D discourse, both under and outside the Paris Agreement.

The volume overall is organised into five sections: Sect. 1 **sets the stage with key concepts and insights** regarding trends in impacts and risks, while Sect. 2 presents **critical issues that increasingly are shaping the policy discourse**. In Sect. 3, **methods and tools for research and practice are reviewed** in terms of their applicability, Sect. 4 presents **place-based evidence** and insights on losses and damages as well as any soft and hard limits **across geographies**, and finally in Sect. 5, **policy options and other actions for the L&D discourse** are discussed. This introductory chapter further elaborates on the evolution of the discourse, presents key concepts of relevance and salience that arise from the book, shortly summarises the individual chapters, and concludes by outlining a number of propositions that link relevant findings to forward-looking suggestions for research, practice and policy.

1.2 Evolution of the Policy Discourse

Formal and informal deliberations regarding "dangerous" climate-related risks and sharing the burdens (including justice considerations) associated with responses to climate change have been fundamental for shaping the climate debate since the beginning (see also chapter by Calliari et al. 2018; see Fig. 1.1). Science, in particular as reported by the IPCC assessments, has had a major impact on policy formulation and decisions as part of the UNFCCC (see Fig. 1.2). Given the ultimate objective as stipulated by the UNFCCC in 1992 "to prevent dangerous anthropogenic interference with the climate system" (UN 1992, Art. 2), the focus of the UNFCCC was originally–and continues to predominantly be–on climate mitigation responses. The first discussions about L&D were initiated by the Alliance of Small Island States (AOSIS) in the early 1990s with due linkages to mitigation. During the negotiations that led to adoption of the UNFCCC in 1992, AOSIS proposed the establishment of, what they called, an international insurance scheme–also referred to by some as a compensation fund–to be supported by mandatory contributions from industrialised parties on the basis of their gross national product and relative greenhouse gas emissions (INC 1991).

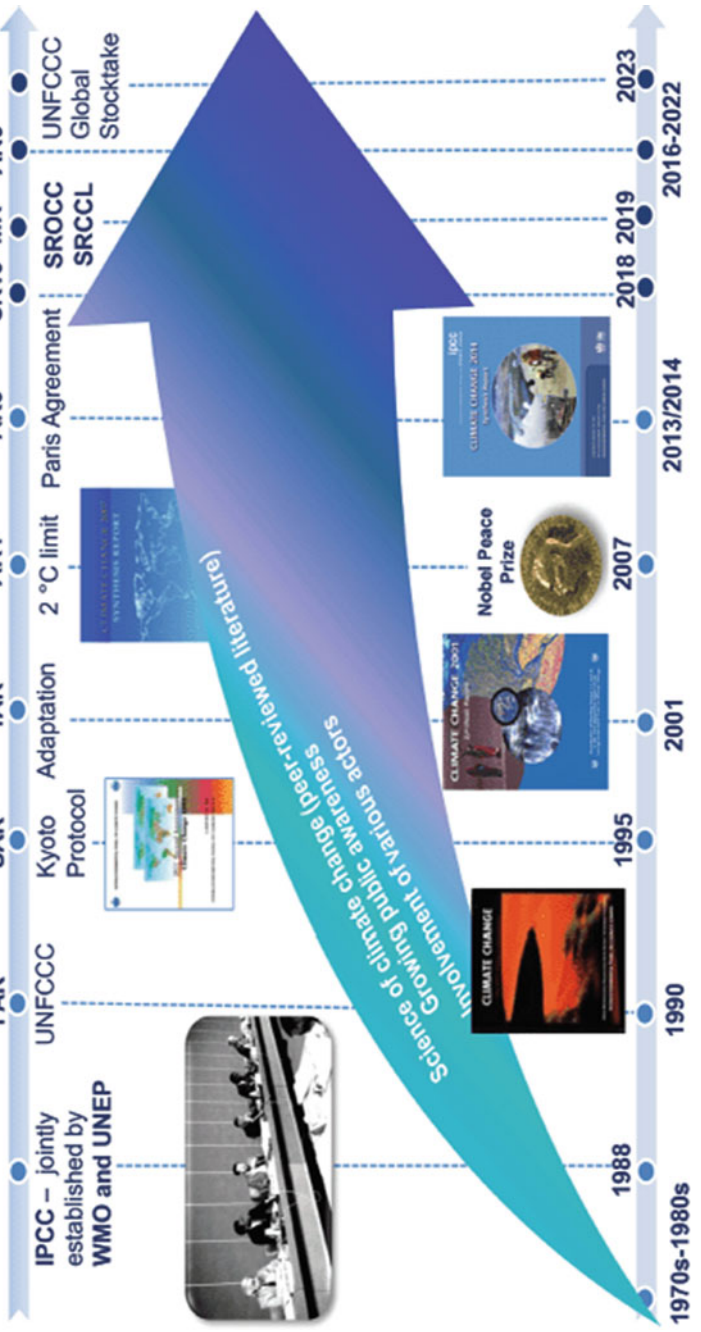

Fig. 1.2 Co-evolution of climate change research reported by the IPCC and the UNFCCC process. *Source* IPCC 2018

The scheme was intended to compensate small island- and low-lying developing nations for climate-related impacts from sea-level rise (Linnerooth-Bayer et al. 2003; AOSIS 2008; see the chapters by Schäfer et al. 2018 and Linnerooth-Bayer et al. 2018). While the proposal was eventually dropped, discussions on compensation and insurance as a means to address the adverse effects of climate change prevailed with expert workshops convened in 2003 and 2007 on the basis of COP decisions 5/CP 7 and 1/CP 10 and COP13 started to consider means to address Loss and Damage (Mace and Verheyen 2016).

In 2008, AOSIS submitted an expanded version of the 1991 proposal to the Ad Hoc *Working Group on Long-term Cooperative Action under the Convention* (AWG-LCA). This *Multi Window Mechanism to Address Loss and Damage from Climate Change Impacts* in Small Island Developing States (SIDS) and other developing countries particularly vulnerable to the impacts of climate change comprised three interdependent components: (1) insurance; (2) rehabilitation/compensation; and (3) risk management (AOSIS 2008). The idea of an "international mechanism addressing risk management and risk reduction strategies and insurance related risk sharing and risk transfer mechanisms" was reiterated a year later in the AOSIS proposal for a Copenhagen Protocol (UNFCCC 2009).

After losses and damages were mentioned in the 2007 *Bali Action Plan* (UNFCCC 2007), the 2010 *Cancun Adaptation Framework* (UNFCCC 2010) initiated formal UNFCCC activities on the issue with the establishment of an ad hoc work programme (UNFCCC 2011). The latter was meant to advance technical work on L&D in three thematic areas over the course of 2011 and 2012: (1) assessing the risk of L&D and the current knowledge on the same; (2) proposing a range of approaches to address L&D from both extreme and slow onset events, taking into consideration experience at all levels; and (3) determining the role of the Convention in enhancing the implementation of approaches to address L&D (UNFCCC 2012). Since its inception, the work programme has conducted several calls for submissions asking parties (national government representatives) and observers (other organisations attending UNFCCC meetings) for input on specific questions. These calls gave parties, observers and non-admitted organisations the opportunity to lay out their views on thematic issues, institutional questions, governance arrangements and suggestions on how to take the L&D work programme forward.

As part of the Doha Climate Gateway in 2012, the Parties decided to establish institutional arrangements to address L&D at COP 19. This laid the groundwork for the creation of the WIM, that is charged to "address loss and damage associated with impacts of climate change, including extreme events and slow onset events, in developing countries that are particularly vulnerable to the adverse effects of climate change" (UNFCCC 2013, para 1). COP19 also established an Executive Committee (ExCom) to guide the implementation of functions of the WIM through an initial 2-year work plan. A distinct L&D article in the Paris Agreement (UNFCCC 2015, Article 8) at COP 21 meant further recognition for L&D and the WIM, and arguably, institutional anchoring within the UNFCCC architecture.

The action areas for work under the WIM have been broad and diverse, ranging in scope and focus. Action areas include considering particularly vulnerable coun-

tries, populations and ecosystems, dealing with both slow- and sudden-onset events, and paying particular attention to non-economic losses. Policy areas include consideration for resilience, recovery and rehabilitation efforts, migration, displacement and mobility, as well as financial instruments including insurance. The work plan is intended to integrate also with other on-going work under the UNFCCC, such as on finance and technology.

Fundamental to this book, and the climate policy debate in general, has been the concept of comprehensive risk management including transformational approaches. The mandate of the WIM includes enhancing understanding of and promoting both short- and medium-term risk management, including risk analysis, risk reduction, risk transfer and risk retention. Furthermore, the WIM is to consider transformational approaches that help to build and strengthen the long-term resilience of countries and communities (UNFCCC 2016, Decision 3/CP.22). Since the establishment of the WIM, the ExCom has met several times and has transitioned from its initial 2-year work plan to a 5-year rolling work plan. Achievements and the WIM will officially be reviewed at COP 25 in 2019.

Recent non-climate policy developments, such as the compact on Sendai (UNISDR 2015), the SDGs (UN 2015), as well as the Nansen Initiative on Displacement (nanseninitiative.org) and its follow-up, the Platform on Disaster Displacement (Displacement Solutions 2015) provide potential opportunities to increase understanding of and respond to growing climate-related risks, including L&D. However, these approaches and preliminary actions are scattered across several sectors and actors, and their relevance to L&D has not yet been systematically evaluated with little exchange between research and policy. In addition, attention to L&D in research and policy has tended to focus heavily on only a few aspects, such as insurance. Broader reflection, particularly on the different dimensions of L&D decision-making has been largely lacking.

While it is difficult to summarise the different strands of the discourse(s), it may be argued that essentially three issues have been highlighted with varying levels of emphasis over time:

1. Burden sharing for the costs of managing climate impacts and risks (losses and damages) including compensation arrangements.
2. Awareness regarding the sensitivity and limitations of human and natural systems to climate change, and the need to respond with stringent climate mitigation policies for limiting warming to 1.5 °C or 2 °C.
3. Support for further risk reduction and risk management interventions for enhancing climate change adaptation and building climate resilience.

Some observers have suggested that there has been a shift in the debate away from "harmful wrongdoing" (1.) to mostly considering support for risk and climate insurance mechanisms (3.) (see Serdeczny and Zamarioli 2018). While indeed, insurance mechanisms have been given substantial attention, it seems that the debate overall has become more comprehensive and the three discursive lines rather exist in parallel offering potential to be further aligned as delineated in this book (see also Mechler 2017).

1.3 The Research Perspective: Definitions and Concepts

1.3.1 Defining Losses and Damages

Many of the issues associated with the L&D discourse are controversial, and given the various perspectives on what exactly L&D might refer to, it is unsurprising that there is no official UNFCCC definition for "Loss and Damage." There are, however, some aspects of L&D that have been relatively widely accepted. UNFCCC documentation consistently states that L&D refers to climate-related impacts and risks from both sudden-onset extreme events, such as flooding and cyclones, and slow-onset events, including sea level rise, glacial retreat, desertification, and others (UNFCCC 2013, 2015). Some analysts have also made a distinction between *losses* associated with irreversibility, for example, fatalities from heat-related disasters or the permanent destruction of coral reefs, while *damages* are referred to as impacts that can be alleviated or repaired, such as damages to buildings (Boyd et al. 2017). Another useful distinction, which has been adopted by many authors (including in this book), was made by Verheyen and Roderick (2008) between *avoided*, *unavoided* and *unavoidable* losses and damages (see Table 1.1).

Avoided losses and damages are those that have been and will be avoided by DRR and CCA. Unavoided impacts and risks are and will not be reduced due to socio-economic constraints and trade-offs (finance, governance, political economy). These unavoided losses and damages are also called residual impacts and risks in the literature (Warner and van der Geest 2013) and are characterised by limits impeding avoidance and reduction. Losses and damages can be material (i.e., physical) or immaterial, as well as economic (measurable in financial or economic terms) and non-economic, with some overlap between these categories (Schäfer and Balogun 2015; Serdeczny 2018). Many consider the L&D discourse to deal particularly with losses and damages "beyond adaptation" and limits to adaptation, that is, unavoided or unavoidable impacts that go beyond adaptation potentials (Verheyen and Roderick 2008; van der Geest and Warner 2015). While adaptation opportunities and barriers

Table 1.1 Classifying losses and damages

Avoided	Unavoided	Unavoidable
Avoidable losses and damages that *can* and *will be* avoided by climate change mitigation and/or adaptation measures	Avoidable losses and damages that are and *will not be* addressed by further mitigation and/or adaptation measures, even though avoidance would be possible. Financial, technical and political constraints, as well as case-specific risk preferences narrow down the adaptation space	Losses and damages that *cannot be* avoided and adapted to through further mitigation and/or adaptation measures, for instance impacts from slow onset processes that have kicked-off already, such as sea level rise and melting glaciers

Classification further developed based on Verheyen and Roderick (2008)

are enablers/disablers for adaptation planning and implementation, adaptation limits have been defined by Klein et al. (2014) as loci at which adaptation actions can no longer guarantee key actor objectives or system's needs can no longer be achieved in the presence of intolerable risks (Dow et al. 2013). These limits can be hard (meaning adaptive technologies and actions are not physically feasible), or soft (technology and/or important socio-economic trade-offs affect priorities today, yet there is potential for overcoming limits in the future) (see also chapter by van den Homberg and McQuistan 2018).

1.3.2 Loss and Damage in the Context of Climate and Disaster Risk Management

In L&D discussions, risk management approaches have received increasing attention. Climate risk management has become the widely accepted methodological framework for assessing potential impacts and devising strategies for adaptation. The IPCC (2014a, p 5.) defines risk as:

> The potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values. Risk is often represented as probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur. Risk results from the interaction of vulnerability, exposure, and hazard.

IPCC's Special Report on Extreme Events (SREX 2012) and the IPCC 5th Assessment Report (IPCC 2014b) define climate risk management (CRM) as an integrative

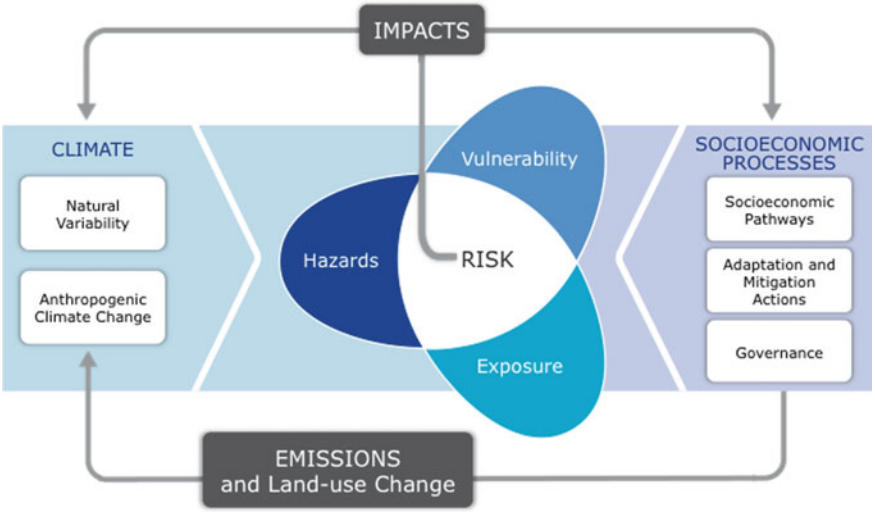

Fig. 1.3 Risk as a function of hazard, exposure and vulnerability. *Sources* IPCC (2012, 2014a)

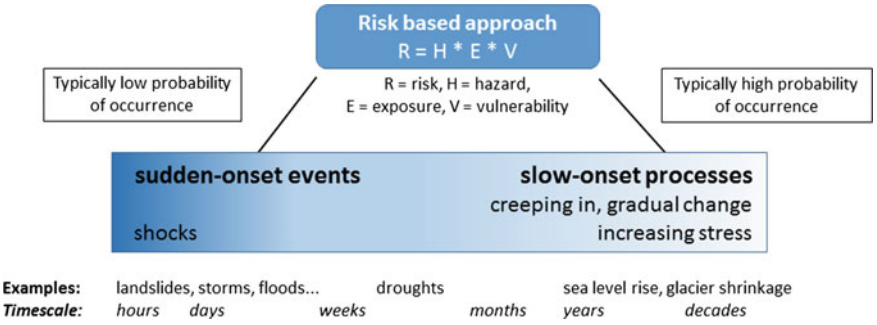

Fig. 1.4 The risk concept as applied to sudden-onset and slow-onset processes. *Source* Huggel et al. (2016a)

framework for understanding and addressing climate-related risks (see Fig. 1.3). CRM broadly may be defined as comprehensively reducing, preparing for, and financing climate-related risk, while tackling the underlying risk drivers, including climate-related and socio-economic factors (Schinko et al. 2016). Climate risk management can build on expertise developed in DRR and CCA research and practice. Firstly, it considers climate risk as a function of hazard (and any climate-related changes), exposure and vulnerability; secondly, it gives proper attention to variability and probability (low frequency vs. high frequency events), calling for probabilistic risk analytical approaches; and thirdly, it accounts for differences in risk perception and the various types of outcomes.

In principle, this climate risk concept can be applied to sudden-onset events and slow-onset climate-related processes unfolding over timescales from hours to days (landslides, storms, floods) to weeks and months (droughts, heat waves), to years (sea-level rise and impacts), and decades (glacial shrinkage) (see Fig. 1.4). In practice, risk analysis has so far usually been applied to phenomena lasting from hours to months. While risk analysis is a key policy tool for climate risk management, including dealing with unavoided losses and damages, it cannot effectively address those impacts that are irreversible and permanent.

1.4 A Broadening Research Landscape–Chapter Summaries

Over the last few years research on L&D has grown in number and focus. In this section, we summarise some of the most relevant findings from the various book chapters providing a review of key topics addressed in the book. Building on forewords by policy makers and negotiators from developing (Dawn Pierre-Nathoniel of the Small Island State of Saint Lucia) and developed countries (Ingrid-Gabriela

Hoven of Germany), the book is divided into five sections, for which we shortly summarise the respective chapters.

1.4.1 Setting the Stage: Key Concepts, Challenges and Insights

The chapter on the **Ethical Challenges in the Context of Climate Loss and Damage** by Ivo Wallimann-Helmer, Lukas Meyer, Kian Mintz-Woo, Thomas Schinko and Olivia Serdeczny sets out the main types of justice and ethical challenges relevant to the L&D debate. The authors argue that a clear differentiation between mitigation, adaptation policy domains and L&D policy is important to understand the normative implications of L&D. They show why *distributive* and *compensatory justice* perspectives are of key relevance to capture all ethical entitlements stemming from adaptation needs and the materialisation of L&D. Of particular importance, the chapter presents a distributive justice perspective for understanding ethical implications of L&D in the short- to medium-term, arguing that L&D can be understood as undeserved harm demanding redistribution to even out this unfairness.

Laurens M. Bouwer in his contribution on **Observed and Projected Impacts from Extreme Weather Events: Implications for Loss and Damage** presents the current knowledge on observed and projected impacts, and risks from extreme weather events in light of anthropogenic climate change. Research on the subject has focused on three key drivers: changes in extreme weather hazards due to natural climate variability and anthropogenic climate change, changes in exposure and vulnerability, and any implemented risk reduction efforts. Studies currently identify increasing exposure as the dominant driver, through growing populations and increases in assets at risk. The chapter further elaborates on how residual weather-related losses (i.e., impacts after implemented risk reduction and adaptation) have not yet been attributed to anthropogenic climate change. The author holds that globally increasing asset exposure will lead to increases in risk, yet presents evidence that vulnerability has declined; thus, it appears there is potential for reducing risks through DRR and adaptation. At country scale, and particularly for developing countries, the evidence points towards increasing risk, indicating the need to significantly upgrade climate risk management efforts and international support. This stage-setting chapter thus shows the challenges in understanding global trends in losses and damages, impacts, and risks from disasters in light of climate change.

Thomas Schinko, Reinhard Mechler and Stefan Hochrainer-Stigler build on the discussions on ethics and trends in impacts and risks. In their chapter on the **Risk and Policy Space for Loss and Damage: Integrating Notions of Distributive and Compensatory Justice with Comprehensive Climate Risk Management** they ask whether a policy framework can be developed around a broad notion of risk to identify a distinct L&D policy space. The authors see ample potential in aligning comprehensive climate risk analytics with distributive and compensatory justice

considerations alongside principles of need and responsibility linked to risk-based actions. Building on the findings of the trends and ethics chapters, the authors develop a policy proposal arguing for international support for needs-based comprehensive climate risk management. At the same time, they also propose to include action on liabilities attributable to anthropogenic climate change and associated impacts. They identify a policy space composed of, what they call *curative* and *transformative* measures. Transformative measures are measures that go beyond the standard toolbox of risk management, also involving actions that change fundamental systems' attributes. Curative action would be triggered through the identification of unavoided and unavoidable losses and damages attributed with relatively *high confidence* to climate change (examples are impacts linked to sea-level rise and glacial retreat; see IPCC 2014a). Presenting and going beyond a public finance application, the authors maintain that the broad risk and justice approach developed may be applied to other highly contested L&D issues such as migration and the preservation of cultural heritage, as discussed elsewhere in the book.

1.4.2 Critical Issues Shaping the Discourse

A number of issues have been critical for shaping the discourse. Importantly, the role of attribution has been in the limelight. The chapter on **Attribution: How is it Relevant for Loss and Damage Policy and Practice?** by Rachel A. James, Richard G. Jones, Emily Boyd, Hannah R. Young, Friederike E. L. Otto, Christian Huggel and Jan S. Fuglestvedt provides an overview of the state of scientific evidence linking losses and damages to anthropogenic greenhouse gas emissions, and takes a critical look at the relevance of this science for L&D policy and practice. The authors' point of departure is a consideration of the existing understanding and perceptions of attribution among policy-makers and observers to L&D discussions. Following several years of research into stakeholder perspectives on attribution and L&D, they find that attribution is often associated with responsibility and blame, and therefore, some might prefer to avoid discussions of attribution. Yet, as the authors argue, attribution science itself is not about responsibility, but rather is a scientific investigation of causal links between elements of the earth system and society. The chapter therefore outlines available research into the causal connections between anthropogenic climate change and L&D from a climate science view focused on changes in hazard, but also from a risk research view that examines the drivers of exposure and vulnerability. The chapter closes with an examination of potential applications of attribution research, highlighting its importance to inform practical actions to avert, minimise and address L&D.

As mentioned, the L&D debate has been strongly shaped by political rationale. Elisa Calliari, Swenja Surminski and Jaroslav Mysiak's chapter on the **Politics of (and behind) the UNFCCC's Loss and Damage Mechanism** reviews political science research and takes an international relations view on the L&D discourse to enhance understanding of current negotiation processes. It also points out ways

forward for research and policy. Adopting a multi-faceted notion of power drawing on neorealist, liberal and constructivist schools of thought, the authors examine the *structuralist paradox* in L&D negotiations in light of the fact that smaller parties to the convention have been able to successfully negotiate key milestones with stronger parties. The authors emphasise the relevance of discursive power for L&D decisions. Framing L&D in ethical and legal terms has been important to developing standards shared and agreed upon beyond the UNFCCC context, including basic moral norms linked to island states' narratives of survival and the reference to international customary law (see also the ethics chapter by Wallimann-Helmer et al. 2018). Looking forward, they however argue that a change in narrative may be conducive to truly achieve collective action on L&D as an issue of common concern countering the risk of the policy debate becoming a win-lose negotiation "game."

Legal actions on climate change have been proliferating in recent years. Florentina Simlinger and Benoit Mayer explore the current status of debate around **Legal Responses to Climate Change Induced Loss and Damage**. The discussion reviews the legal literature, scoping out the spectrum of potential legal actions on L&D including key challenges and possible directions for further research. The discussion broadly examines private and public climate change litigation with examples from around the world. It also lays out how human rights issues have been applied in international law with a view towards L&D. As one focus, the authors examine the applicability of the *no-harm principle* in climate change. This principle, which has long been applied in international law, requires states to refrain from activities that have potential to cause significant transboundary harm, and to prevent actors within its jurisdiction from carrying out such activities. The chapter, furthermore, presents legal actions with relevance for L&D negotiations. A synopsis of the various legal responses to L&D highlighting their premises, specific challenges and proposed remedies, provides a succinct summary of the discussion.

Non-economic Loss and Damage (NELD) is a distinct theme in the work plan of the Loss and Damage Executive Committee (WIM Excom). The chapter on **Non-economic Loss and Damage and the Warsaw International Mechanism** by Olivia Serdeczny starts by providing a definition of NELD as climate-related material- and non-material impacts, risks to well-being, and assets and goods not commonly traded in the market. Examples comprise loss of cultural identity, sacred places, as well as human health and lives. Initial analysis shows that the two main characteristics of non-economic values are their context-dependence and incommensurability. The author suggests that these attributes need to be preserved and respected when considering measures to avoid the risk of NELDs as part of comprehensive risk management approaches. Addressing NELDs in a central mechanism under the UNFCCC requires substantial understanding of the permanently lost values and their functions for those negatively affected.

Studies of L&D from climate change have focused strongly on human systems and tended to overlook the mediating role of ecosystems and the services ecosystems provide to society. This is a significant knowledge gap as losses and damages to human systems often result from permanent or temporary disturbances to ecosystems services caused by climatic stressors. The chapter on the **Impacts of Climate**

Change on Ecosystem Services and Resulting Losses and Damages to People and Society written by Kees van der Geest, Alex de Sherbinin, Stefan Kienberger, Zinta Zommers, Asha Sitati, Erin Roberts and Rachel James advances understanding of the impacts of climatic stressors on ecosystems in light of the implications for losses and damages to people and society. The chapter develops a conceptual framework for studying the complex relations, which is applied to a case study of multi-annual drought in the drylands of the West-African Sahel. This case study exhibits the complexity of causal links between climate change, climate variability and specific weather and climate events leading to losses and damages, including warming, multi-decadal drought, and flooding. The authors conclude the chapter by advising against the oversimplification of causality and suggest that governance and natural resource management should be given attention in future research and policy discussions.

How do we understand displacement and resettlement in the context of climate change? Alison Heslin, Natalie Delia Deckard, Robert Oakes and Arianna Montero-Colbert's contribution on **Displacement and Resettlement: Understanding the Role of Climate Change in Contemporary Migration** presents challenges and debates in the literature on climate change impacts and the growing global flow of people. The authors position their discussion within the literature on environmental migration, presenting associated definitions, forms of environmental migration and ways to measure the movement of people. The literature on the reception of migrants and migrant resettlement is also presented. The discussion is contextualised through a selection of cases where the environment plays a role in displacing populations, including sea level rise in Pacific Island States, cyclonic storms in Bangladesh, desertification in West Africa, and deforestation in South America's Southern Cone. The examples highlight the complex set of losses and damages incurred by population displacement in each case.

1.4.3 Research and Practice: Reviewing Methods and Tools

The chapter on the **Role of the Physical Sciences in Loss and Damage Decision-Making** by Ana Lopez, Swenja Surminski and Olivia Serdeczny elaborates on contributions that physical climate science can make to improve decision-makers' understanding of climate-related losses and damages. For climate science both the present and future are of relevance when estimating actual and potential losses and damages associated with climate change. For both timescales climate science seeks to understand those aspects that determine the climate-hazard, including the links between human induced changes in climate and climate variability, the probability of occurrence of extreme meteorological events (e.g., rainfall), and the resulting hazards leading to losses and damages (e.g., flood). The chapter reviews the approaches used to assess this component of risk. Particular attention is paid to the identification of sources of uncertainty and the potential for providing robust information to support decision-making. As the authors demonstrate, uncertainty does not imply policy

inaction. To this end, they present tools and approaches developed in the context of CCA and DRR, which, as the authors show, are also of relevance for L&D.

Understanding all components of impacts and risks is crucial for considering further policy actions. Wouter Botzen, Laurens Bouwer, Paolo Scussolini, Onno Kuik, Marjolijn Haasnoot, Judy Lawrence and Jeroen Aerts present approaches for **Integrated Disaster Risk Management and Adaptation** aimed at informing L&D policymakers. Insights provided refer to how risk management and adaptation options interact with options discussed in the L&D debate (such as insurance), as well as how L&D-related activities may support risk reduction and adaptation in vulnerable communities and countries. The authors particularly focus on outlining how risk management can help people and societies to adapt to the increasing impacts of weather-related disasters in relation to anthropogenic climate change. The perspective established is one of holistic risk management comprising state-of-the-art risk assessment methods, socio-economic evaluations of risk management and adaptation options—including household-scale risk reduction strategies and insurance schemes for residual risk. The method of adaptation pathways is presented as an innovative contribution for coping with uncertainty in the timing and intensity of climate change impacts. Case studies on Jakarta, Ho Chi Minh City, Mexico, Bangladesh, Netherlands, New Zealand and Germany illustrate each of these topics with concrete insight.

Laura Schäfer, Koko Warner and Sönke Kreft's contribution on **Exploring and Managing Adaptation Frontiers with Climate Risk Insurance** follows a similar vein as the adaptation pathways proposition discussed above. The authors suggest that climate insurance, a key focus of policy discussion and implementation, may serve as an entry point and tool for exploring adaptation frontiers, which are closely linked to the concept of limits and defined in the literature as a "transitional space between safe and unsafe domains" (Preston et al. 2014). Introducing climate risk insurance (also covered in the chapter by Linnerooth-Bayer et al. 2018), the authors propose three routes through which an insurance focus may contribute to this exploration. The first route provides an action-focussed framework for signalling the magnitude, location, and exposure to climate-related risks, as well as on any actual and potential adaptation limits. The second route supports actors in moving away from adaptation limits by improving ex-ante decision making, incentivising risk reduction and reducing uncertainty around climate-resilient development, while the third route helps actors to stay within the tolerable risk space by facilitating financial buffering as part of risk financing approaches. The authors also highlight that insurance-based approaches are not a silver bullet, and suggest that these are effectively embedded in a comprehensive climate risk management framework integrating other risk-reduction and management strategies (for a similar point, see the chapter by Wallimann-Helmer et al. 2018).

Unsurprisingly, climate finance has been a hot topic for the L&D debate and has been receiving a lot of emphasis in current policy dialogue (in 2018 it is the focus of the so-called *Suva Dialogue* under the UNFCCC informing potential actions on finance leading up to the WIM review in 2019). The evidence base is, however, almost non-existent and there are very few empirical and model-based estimates

of L&D finance needs. Anil Markandya and Mikel González-Eguino present what we can learn about possible L&D finance needed from an economic angle in the chapter on **Integrated Assessment for Identifying Climate Finance Needs for Loss and Damage: A Critical Review**. This economic perspective presents and critically reviews a methodological approach that builds on economic rationality for modelling market-based and monetised risks, and actual and perceived trade-offs between investment into income-generating actions, climate mitigation and adaptation. Specifically, the authors present estimates using Economic Integrated Assessment Modelling (EIAM), which calculates economically optimal responses to climate change mitigation and adaptation in terms of maximising welfare (GDP) a few decades into the future. Interpreting modelled residual damages as unavoided losses and damages, a number of implications emerge from the analysis. The authors emphasise that uncertainties are very large and any meaningful projections of residual damages in the medium to long term are currently not feasible. Furthermore, residual damages are found to strongly vary by region as well as by climate scenario. Overall, the chapter finds residual damages to appear significant under a variety of models, and for a range of climate scenarios for both developing and developed countries.

1.4.4 Geographic Perspectives and Cases

Many chapters in this volume contextualise their discussions and findings with examples of place-based insight. The section on geographic perspectives and cases focuses strongly on local experience in relation to L&D. Small Island Developing States (SIDS), being highly vulnerable to climate change due to, among others impacts, sea-level rise and associated consequences, started the discussion on L&D and are very vocal in the debate. John Handmer and Johanna Nalau localise the global debate by focusing on Pacific SIDS in their contribution on **Understanding Loss and Damage in Pacific Small Island Developing States**. Specifically, the authors provide commentary regarding the risk and options space (as discussed in Schinko et al. 2018 and Mechler and Schinko 2016) in the Western Pacific SIDS context, particularly in Vanuatu, where many of the livelihood activities are subsistence-based, reliant on the current climate and its variability, and already seriously disrupted by extreme weather events. As the authors show, for some low-lying island states climate change poses an existential threat, and the region is increasingly recognised as one that is most immediately vulnerable to potential mass migration and relocation due to climate change. The authors thus find the options-policy space for SIDS very constrained as demonstrated through evidence on soft (intolerable risk) and hard limits (irreversible high-level risk). The authors conclude with a proposal to mainstream L&D aspects into sectoral policies and strategies in Pacific SIDS in order to better manage the soft limits and understand any hard limits that could affect vulnerable communities.

Migration and displacement driven by climate-related impacts and risks is a reality in the Pacific and other regions. The chapter on **Climate Migration and Cultural**

Preservation: The Case of the Marshallese Diaspora by Alison Heslin expands that conversation by addressing the consequences of the relocation of Marshallese Islanders on their cultural heritage, an important component of NELD. The low-lying islands of the Republic of the Marshall Islands, with little capacity to withstand even minor increases in sea level and tides, are an important case in point, as its population is faced with relocation in the immediate future. Interestingly, nearly a third of the population already lives outside of the Marshall Islands, benefitting from visa free entry into the United States. This provides an evidence base for helping to anticipate future challenges faced by those who will be displaced by rising sea levels. The study draws on data from interviews with migrants from the Marshall Islands regarding accounts of life in the United States and identifies challenges (differences in livelihoods, family structures, food habits, etc.), as well as opportunities (better access to various forms of employment, improved healthcare and cultural preservation in the midst of the Marshallese diaspora). The study closes by laying out how understanding the means through which Marshallese migrants maintain cultural traditions and the challenges they face can help to address potentially irreversible, but in this case, avoidable losses of cultural traditions in the event of mass displacement from these small islands.

Suggestions have increasingly been brought forward regarding the potential for partnerships between public and private sectors and civil society for devising and implementing options that manage critical climate-related risks at scale. But how are such models and partnerships organised? What can be learned from existing activities and how can learning be upscaled? The chapter **Supporting Climate Risk Management at Scale: Insights from the Zurich Flood Resilience Alliance Partnership Model Applied in Peru and Nepal** by Reinhard Mechler, Colin McQuistan, Ian McCallum, Wei Liu, Adriana Keating, Piotr Magnuszewski, Thomas Schinko and Finn Laurien reports on the learnings from one such partnership, the Zurich Flood Resilience Alliance–a multi-actor partnership launched in 2013 to enhance communities' resilience to floods at local to global scales. The chapter presents learnings from two cases where flood risk, amplified by climate change, has been eroding livelihoods leading to some soft limits. In the Karnali and Koshi river basins in Nepal, communities are facing rapid on-set flash floods during the monsoon season that, in the absence of appropriate early warning technology, have led to severe loss of life and assets. In the Rimac and Piura river basins in Peru, the wellbeing of communities in the absence of effective preparedness has been severely affected by low probability, but high impact El Niño episodes. Options to overcome these impacts have included identifying novel evacuation routes and emergency plans, the development of flood brigades, and supporting communities to interact with local governments on DRR planning. This critical examination of the experience across geographies and scales leads the authors towards suggestions for identifying novel organisational, funding and support models involving NGOs, researchers and the private sector, side by side with public sector institutions.

The Arctic is a "laboratory" of physical transformation, where climate change is happening about two times faster than the global average; there is high evidence that meltwater from Arctic sources accounts for 35 percent of the current global

sea level rise. Local impacts are of relevance as well, particularly those on social systems and responses. Arctic communities have had to seek ways to deal with rapidly changing environmental conditions that are leading to social impacts such as through outmigration, similar to the experience in the global South. Yet, the international debate on L&D has not sufficiently addressed the Arctic region so far. In their chapter on **Loss and Damage in the Rapidly Changing Arctic** Mia Landauer and Sirkku Juhola provide the first such research contribution reviewing the literature to show what impacts of climate change are already visible in the Arctic. The authors present a literature review with local cases to provide empirical evidence of climate losses and damages in the region. Particularly, they show that there is solid evidence and examples of outmigration and relocation. In addition to the implications of Arctic losses and damages for the international debate, the authors suggest a need for new governance mechanisms and institutional frameworks to tackle losses and damages in this quickly changing region.

1.4.5 Policy Options and Other Response Mechanisms for the L&D Discourse

The final section of the book deals with policy options and other response mechanisms relevant to L&D. The chapter by Masroora Haque, Mousumi Pervin, Saibeen Sultana and Saleemul Huq on **Towards Establishing a National Mechanism to Address Loss and Damage: A Case Study from Bangladesh** reports on innovative efforts that are underway to establish a national mechanism that addresses losses and damages in Bangladesh–a highly climate-vulnerable country which, at the same time, is one of the forerunners in comprehensive risk management. Bangladesh has a history of well-established DRR policies involving institutions at national and sub-national levels, as well as political and regulatory institutions. Furthermore, the country has been one of the first to establish a National Adaptation Programme of Action (NAPA), which has led to the Bangladesh Climate Change Strategy and Action Plan. Loss and Damage is currently not explicitly addressed, yet particularly the work area on comprehensive Disaster Management provides an entry point with activities underway or planned on insurance, as well as on tackling climate migration and displacement. Taking explicit account of L&D is the main gap in Bangladesh's adaptation and DRR policy framework, and thus the motivation behind the plans is to set up a legislative, institutional and policy-related mechanism to address climate-induced losses and damages.

As presented by Florentina Simlinger and Benoit Mayer, legal actions on climate change are proliferating. The contribution by William Frank, Christoph Bals and Julia Grimm on the **Case of Huaraz: First Climate Lawsuit on Loss and Damage against an Energy Company before German Courts** reports on the first climate litigation lawsuit in Germany and the first specifically on L&D. The case has been brought forward by the plaintiff, Saul Luciano Lliuya of the city of Huaraz in the

Andes nestled just below the Palcacocha glacial lake. Global warming has led to dangerous increases in the lake's volume, increasing the risk of a glacial ice avalanche. Such an avalanche would cause an outburst flood from the lake potentially leading to massive destruction and loss of life. As a precedent, in 1941 an outburst flood killed more than 5,000 people in Huaraz. Saúl Luciano Lliuya's climate lawsuit, brought forward with support from the German NGO Germanwatch in 2016 against the German energy company RWE, seeks support from the company to make a contribution to risk measures that avoid such a glacial lake flood, proportional to the company's share in historical CO_2 emissions (about 0.5% overall). The case, dismissed in the first instance, has since been accepted by a higher regional court in Germany after an appeal, and is now (mid 2018) in the midst of the evidentiary stage.

Much of the L&D debate has focused on climate risk insurance as a possible response mechanism. This policy response is explored by JoAnne Linnerooth-Bayer, Swenja Surminski, Laurens M. Bouwer, Ilan Noy and Reinhard Mechler in **Insurance as a Response to Loss and Damage?** The chapter reflects on recent evidence and questions whether insurance instruments can serve the *prevention* and *cure* intentions of the WIM and the Paris Agreement, in terms of reducing climate-related risk and providing an equitable response to L&D from weather extremes in developing countries. The chapter lays out the forms and functions of insurance for climate-related extremes and emphasises the substantial benefits as well as the substantial costs of both micro-insurance programs and regional insurance pools for providing post-disaster relief and reconstruction. Notwithstanding the actual and potential benefits, the authors find that absent significant intervention in their design and implementation, insurance mechanisms as currently implemented, will likely fall short of fully serving the *preventive* and *curative* aspirations of developing country parties to the WIM. The authors emphasise the importance of burden-sharing, as insurance is generally *loaded* with an expense and risk margin in addition to the profit margin for commercial insurance. The chapter, while advising caution about relying largely on market solutions to provide insurance for fulfilling the prevention and cure aspirations, thus emphasises the criticality of international and public intervention in climate risk insurance provision.

Technology plays a critical role in coping with climate impacts and risks so that adaptation limits are not further breached. Yet, vulnerable communities disproportionally impacted by climate change, often cannot benefit from existing technology. Those engaging in the L&D debate have only very recently sought dialogue with discussions on technology, such as under the UNFCCC. The chapter **Technology for Climate Justice: A Reporting Framework for Loss and Damage as part of Key Global Agreements** by Marc van den Homberg and Colin McQuistan examines how technology can shape limits to adaptation and how international reporting on technology (in)justice as part of key global agreements may help. The authors develop a technology-reporting framework with components of access, use and innovation, which is consequently applied via the example of transboundary early warning systems deployed in South Asia. They find that for vulnerable countries only a limited set of state-of-the-art technologies is available, and the reality of capacity and funding gaps means only the bare minimum, largely copycat types of technology, is utilised.

Similar to the ethics chapter, the authors thus argue that more attention to distributive, compensatory and procedural climate justice principles in terms of distributing technology, building capacity and providing finance is sorely needed to widen the access, use and innovation of the technology spectrum available to developing countries. The authors finally suggest to include technology for climate justice in the Adaptation Communications, and making reporting mandatory on actual and expected impacts of L&D measures.

1.5 From Findings to Propositions for the Loss and Damage Debate

The book chapters cover specific issues showing the wide variety of research on L&D, as well as the many interconnections, shared concepts, tools and methods. In this section, we align some of the key findings and suggestions for moving forward. We identify five key propositions that, as we assert, hold potential for providing a roadmap for further 'grounding' the so far highly political debate. The propositions are essentially cross-cutting and reflect the architecture of the book in terms of considering insights from the various sections (setting the stage, critical issues, methods and tools, cases, policy options). The propositions each build on relevant findings that then inform suggestions for an actionable element to be taken forward by research, policy and practice.

Proposition 1 *Risk management is an effective entry point for aligning perspectives and debates. Framed comprehensively, coupled with climate justice considerations and linked to established risk management practice, it may help to identify a distinct policy space for Loss and Damage.*

The L&D debate has been polarised between those advocating for compensation for actual losses and damages, and others suggesting support for tackling future risks by (further) employing disaster risk management and climate insurance solutions. While L&D remains a political concept developed during the UNFCCC negotiations, it has (some of) its technical roots in risk management, which can be built upon to identify a joint and distinct policy space (see chapters by Schinko et al. 2018; Botzen et al. 2018; van den Homberg and McQuistan 2018).

Risk management brings along established practices for dealing with extreme events and any trends therein, and thus may provide an operational framework with a tested set of methods and tools (see Bouwer 2018; Botzen et al. 2018). Yet, a broader perspective on climate risk research and policy appears sorely needed. In its 5th Assessment Report (IPCC 2014b), the IPCC laid the foundations for such a perspective by broadly defining climate-related risks and the potential (as well as limits) for adaptation to key risks faced by geographic regions both today and in the future, characterised by scenarios of aggressive or business-as-usual mitigation and adaptation. This perspective requires to take into account non-economic losses and

damages (NELD) such as to human health and lives, but also losses of cultural identity and sacred places. The issue of NELD, which has garnered substantial attention in the discourse, but is generally not accounted for in standard DRR approaches, implies a need for well considering its two main characteristics, context-dependence and incommensurability (Serdeczny 2018).

Understanding and acting on climate risks is intricately linked to justice and ethical considerations. Justice and fairness issues have played a key role in the climate change policy and academic discourse since the beginning of the UNFCCC process–most prominently through the distributive justice principle of "common but differentiated responsibilities" (UNFCCC 1992). These considerations also come into play when contemplating issues of compensatory justice due to the unequal distribution of historical and current greenhouse gas emissions, the adverse distribution of impacts between the global North and South, and the understanding that climate change is projected to lead to unavoidable and potentially irrecoverable losses and damages (chapter by Wallimann-Helmer et al. 2018). Building on risk and justice principles, Schinko et al. 2018 propose a distinct L&D policy action space that can be identified by aligning a needs-based, distributive justice perspective, proposing support for transformative climate risk management beyond adaptation possibilities, with a compensatory justice perspective which upholds considerations for curative options for liabilities attributable to anthropogenic climate change (see also Mechler and Schinko 2016).

Interestingly, both types of principles and policy actions are already seeing some, if incipient, attention today. *Transformative risk management* is increasingly debated in the L&D discourse, and involves issues such as offering alternative livelihoods to those that are being affected (e.g., switching from smallholder farming to service sector employment) and assisting with voluntary migration where needed. Options under this rubric exhibit substantial overlap with interventions of disaster risk reduction and adaptation, yet may be focussed further on avoiding and managing intolerable risks that touch on hard and soft limits. Insurance applications, a mainstay of policy attention, e.g., through the G20/V20 InsuResilience initiative (InsuResilience 2017), can in principle be a useful entry point for tackling transformation; yet, caution must be exercised about commercial insurance products that place the full burden on the most vulnerable. Premium support in the form of subsidies and technical assistance can potentially transform insurance into a mechanism that meets the aspirations of the L&D discussions. Insurance options furthermore hold additional potential by serving as a concept and tool for exploring the magnitude and locations of adaptation frontiers, "socio-ecological system's transitional … operating spaces between safe and unsafe domains" (Preston et al. 2014) (see chapters by Schäfer et al. 2018 and Linnerooth-Bayer et al. 2018).

Complementing transformative risk management, largely appropriate for sudden-onset impacts and risks, with efforts for dealing with slow-onset events, the space for *curative* measures overlaps to some extent with demands for compensation, which have been ruled out by the Paris Agreement, but not from the debate in general (see chapters by Simlinger and Mayer 2018; Schinko et al. 2018). In addition to policy proposals in the domain of insurance, essentially a pre-arranged compensation

mechanism for any losses and damages funded by premium payments of those at-risk, via a climate attribution-triggered capitalisation mechanism (see proposition 4), the most advanced ideas in the context of curative measures have been articulated with regard to support for involuntary climate-induced displacement and forced migration. A climate displacement facility is being discussed under the WIM and proposals for approaches to address climate-induced displacement have been made (e.g., through the Nansen Principles on Climate Change and Displacement (NRC & IDMC 2011) and the Peninsula Principles on Climate Displacement within States (Displacement Solutions 2015).

Identifying the financial costs associated with such a distinct risk and policy L&D space is currently extremely difficult–particularly as the remit of action has not been concretised. There are some limited studies extrapolating from estimates of climate impact and adaptation costs. If L&D is framed as dealing with residual impacts after adaptation, models using economic optimality reasoning calculate impact and option costs in the billions of US dollars; yet, as Markandya and González-Eguino (2018) find, there is currently *low confidence* regarding damage costs, cost of adaptation and residual impacts. Beyond finance considerations, the risk management approach to L&D—if framed comprehensively (with associated principles, methods and tools)—may indeed embrace some of the other salient perspectives of the discourse, such as those emphasising burden sharing and the limits to adaptation, and thus help to constitute a systematic platform for future work of the WIM and beyond (see chapter by Lopez et al. 2018).

Proposition 2 *Attribution science is advancing rapidly, leading to increased understanding of the causal connections between emissions, climate, human systems, and Loss and Damage. While the science has often been associated with responsibility and blame, its aim is to analyse drivers of change fundamental to informing actions to minimise, avert, and address loss and damage.*

Climate change attribution research originally focused on examining drivers of observed changes in global temperature. Attributing losses and damages is much more complex and requires investigating how anthropogenic greenhouse gases (GHGs) influence many other climatic variables apart from global temperature, as well as their influence on the oceans, cryosphere, biosphere, and human systems on a range of timescales. It also requires a comparison of the influence of anthropogenic emissions on hazards, with other potential drivers (for example land use change, and aerosols), as well as drivers of exposure and vulnerability. Therefore, this is not only a question for climate scientists, but requires integration of research from a number of scientific fields. Researchers are stepping up to this grand challenge and have made rapid advances, particularly in a new field of climate change attribution research focusing on single extreme weather events. This now allows statements to be made about how anthropogenic emissions have influenced the likelihood or magnitude of specific heatwaves, heavy rainfall events, wind storms, and droughts. Several recent event attribution studies have also demonstrated the influence of GHG emissions on the probability of monetary losses from flooding and loss of life from cold- and heat-related events (see chapter by James et al. 2018).

The evidence base on climate impacts is growing. As summarised in IPCC's AR5, impacts of climate change have been observed on all continents and across all oceans. There is *high confidence* that worldwide glacial retreat, permafrost thawing, and mass bleaching of coral reefs can be mainly attributed to climate change (IPCC 2014a). Yet, impacts to human systems and specific events are much harder to assess due to multifactorial causation, and in particular, since vulnerability reducing actions have been employed in many locations and for many weather-related hazards (see chapters by Bouwer 2018; Lopez et al. 2018). Therefore, despite the advances, it may never be possible to generate a complete inventory of L&D attributable to anthropogenic emissions. In addition to the uncertainties inherent in the attribution problem, a lack of robust time series data in many hot spot locations hinders progress in research and risk management (Huggel et al. 2016b). Thus, policy-advisors and negotiators should not expect the emergence of fully conclusive evidence regarding the influence of climate variability and change on specific incidences of losses and damages and, in particular, should not expect the strength of evidence to be equivalent between events and between countries.

Some of the most frequently discussed applications of attribution science for L&D have been made in relation to liability and legal responses. Attribution research is relevant to private and public administration litigation as well as to breaches of customary international law—the *no-harm principle* (see chapter by Simlinger and Mayer 2018). In the case of litigation before a national or international court or tribunal, legal cases are faced with a myriad of technical difficulties, particularly what concerns the issue of causality. Litigation requires diligence to prevent or minimise harm, as well as considering the indirect consequences of harmful wrongdoing in addition to direct impacts, which are normally considered in litigation. Thus, the case of Lliuya versus RWE, which is currently (mid 2018) in the evidentiary stages after having been admitted to a higher regional court in Germany, is exemplary in two regards. It is considered the first case on L&D in Germany and elsewhere, as several tort-based cases have been rejected by, for example, courts in the USA. It also innovatively seeks remuneration for risk management efforts to be undertaken to avoid future, irreversible risk (loss of life) associated with glacial lake outburst flooding affected by glacial retreat attributed with high confidence to anthropogenic climate change (see chapter by Frank et al. 2018). Given the many technical difficulties to be addressed, for legal actions overall, it may be interesting to consider working with a so-called *modified general causation test*—as has been done successfully for other risk classes, such as tobacco, nuclear risk etc. (see chapter by Simlinger and Mayer 2018). This would mean focusing on proving that GHG emissions are *generally* capable of causing damages and that a causal link between action and damage is *probable*. Such a rationale would render the requirement to attribute a specific climatic event to the emissions of a specific person or entity unnecessary. Therefore, a lack of attribution evidence may not necessarily be a limiting factor in some legal responses. Overall, attribution research has the potential for much broader applicability. It has an important role to play in helping to understand losses and damages, including through the quantification of risks; investigating the relative importance of different drivers of change; and identifying timescales on which significant impacts

of climate change emerge in different regions of the world. All of these applications are fundamental to informing actions to address, avert and minimise losses and damages.

Proposition 3 *Climate change research has focused on understanding physical/hard limits to adaptation, but less so on the soft limits, which are strongly shaped by social processes. Applying a multiple lines of evidence framework, we find that soft limits to intolerable risk are already being breached in several geographies globally. Climate change is a key factor, yet exposure growth and vulnerability dynamics particularly need attention for a comprehensive understanding.*

While research on adaptation limits is still in its infancy, the L&D debate has had some focus on adaptation limits, which have been defined as points beyond which actors' objectives are compromised by intolerable risks. Adaptation research has focused on how climate-related hazards lead to hard adaptation limits, that is, where no adaptive technologies and actions are feasible anymore (see also chapter by van den Homberg and McQuistan 2018). Soft adaptation limits, characterised by a lack of options and concurrent socio-economic trade-offs, have received less attention. In addition, empirical research on losses and damages has only recently started to consider the mediating role of ecosystems and their services provided to society (van der Geest et al. 2018). Notably, a very recent volume co-edited by Johanna Nalau, an author in this book, provides a first comprehensive overview of research and experience on adaptation limits (see Filho and Nalau 2018). As one methodological contribution along a multiple lines of evidence approach, risk analysis shows a way forward for identifying hard and particularly soft limits. Starting with risk identification for assessing risks in monetary and/or non-monetary terms, the process of risk evaluation examines the ability of agents (households, private and public sectors) to respond to risk leading to qualifications and quantifications of risk (in)tolerance.

The cases presented in this volume provide a multiple lines of evidence approach for considering any actual or potential adaptation limits. The research documented in the book has generated evidence that poor and vulnerable people and communities already persist at the edges of these boundaries and limits. Overall, the case studies in this book report multiple instances where soft and hard adaptation limits are (at risk of) being breached. Climate change is generally a key factor, yet other drivers and constraints also need to be understood and addressed. In addition, observed vulnerability dynamics imply that adaptation and building resilience lead to reductions in vulnerability.

Pacific Island states are particularly vulnerable to sea level rise, high tides, and salinisation, but also to droughts. Some communities experience seasonal food shortages, and malnutrition is common, indicating that part of the Pacific (as discussed for the state of **Vanuatu**) is already at or near the tolerable/intolerable interface. As a result, relocations and some resettlement are already occurring or planned (Handmer and Nalau 2018). As people move, understanding the means through which SIDS migrants maintain cultural traditions and the challenges current migrants face can

help address potentially irreversible, but avoidable, losses of cultural traditions in the event of mass displacement as analysed for the **Marshall Islands** (Heslin 2018).

Faced with the increasing impacts of climate change and recognising that gains in development and poverty alleviation are severely hampered by climate change, the government of **Bangladesh** is planning to set up a national L&D mechanism to support those that have already incurred significant losses and damages beyond adaptation (Haque et al. 2018). Flood climate risk management case studies on **Nepal, India, Bangladesh** and **Peru** show limits to adaptation due to inadequate transboundary governance, insufficient devolution of mandates and funding to lower administrative levels, as well as inadequate access to and use of technology (chapters by Mechler et al. 2018b; van den Homberg and McQuistan 2018).

A case study on the **Sahel** and the semi-arid drylands of **East Africa** discusses how climate variability and change have affected primary productivity and food production as supporting and provisioning ecosystem services. Losses and damages reported in this context are livestock losses, food insecurity, displacement, cultural losses (including traditional livelihood systems), and finally, conflict related to these. The case also shows that oversimplification must be avoided in a context of multiple risk factors, including the governance or management of natural resources. Examples for risk factors presented are a lack of investment in water-related infrastructure, gaps in access to agricultural technology, barriers to pastoralists' freedom of movement, or lack of health care services, which have also contributed to increasing losses and damages (van der Geest et al. 2018).

Migration, particularly if forced, is an example of "beyond the limits of adaptation." Contextualising migration as multifactorial, a selection of cases including sea level rise in **Pacific Island States**, cyclonic storms in **Bangladesh**, and desertification in **West Africa**, as well as deforestation in **South America**'s Southern Cone, presents instances of migration driven by climate change and variability, as well as other factors (Heslin et al. 2018). The **Arctic** case on relocation and outmigration provides examples of instances "beyond adaptation" due to institutional, political, organisational and jurisdictional factors hindering implementation of adaptation to climate impacts, thus leading to losses and damages (Landauer and Juhola 2018).

Proposition 4 *Insurance mechanisms can only serve the prevention and cure aspects emphasised in the L&D debate if they are made affordable with support from outside the insurance pool, and if they are purposefully designed to encourage or prescribe risk reduction. While their applications are limited to sudden onset events, insurance instruments can help to explore adaptation frontiers, in which many factors, including technology, play a role.*

Climate insurance has been one of the foci of debate on L&D and the WIM work plan. Recent experience, however, shows that insurance instruments can only serve as a risk-reducing and equitable response to losses and damages from weather extremes in developing countries if they are designed to explicitly reward risk-reducing behaviour and if they are supported by those outside the insurance pool. Commercial insurance is based on the principle of mutuality, according to which the

insured participate in a disaster pool according to their risk class and pay a risk-based premium. Thus, the commercial insurance approach, unless subsidised or otherwise supported, does not share risk beyond the at-risk insured community.

This stands in contrast to most micro-insurance and regional insurance pools, which for the most part receive substantial support from the international community. Support appears to be increasingly based on the concept of *solidarity*, consistent with the humanitarian principles underlying development assistance, and not on attribution or responsibility for climate change impacts experienced by vulnerable countries. A common challenge with the solidarity principle, which features subsidies and other support to reduce premiums, is its failure to incentivise policyholders to reduce their risk. In meeting this challenge, international financial institutions, development agencies and other donors will need to reconcile the contending equity and preventive objectives in their support of climate insurance programs.

Two examples of insurance instruments serving the poor, the African R4 micro-insurance program and the African Risk Capacity (ARC) regional insurance pool, combine these goals. Neither is a commercial insurance enterprise; neither is fully characterised by risk-based premiums underlying the principle of mutuality; and both are highly subsidised. The R4 program's success has largely been attributed to its close connection with public safety net programs in the participating countries, while ARC requires member governments to develop disbursement plans to ensure that the most vulnerable parts of the population benefit from the macro scheme. Moreover, ARC's innovative Extreme Climate Facility (XCF) program may additionally bring in the concept of *accountability*, motivated by a perceived ethical or legal obligation for compensating those experiencing climate-attributed losses and damages, linked to changes in observed extreme weather in the region (Linnerooth-Bayer et al. 2018).

In general terms, insurance is a pre-arranged compensation mechanism for losses incurred and can be offered by both private and public actors. Public relief or catastrophe funds serve a similar function, while neither collecting premiums nor (typically) estimating risks. Many countries in the world have contingency funds to support victims of disasters. In Bangladesh, there is debate on whether to set up a national mechanism that would reimburse climate-related losses incurred by farmers and households that go beyond their adaptation possibilities (for example, if flooding pushes people to leave their homesteads or drought renders farming not profitable) (Haque et al. 2018).

In such a context, insurance in a wider sense (including national compensation pools) may innovatively be used as a navigational tool for exploring the adaptation frontiers (broad loci around adaptation limits). Such exploration may involve: (i) signalling the magnitude, location, and exposure to climate-related risks and cases where adaptation limits are approached or breached; (ii) supporting actors to move away from adaptation limits through improved ex-ante decision making and incentivising risk reduction and adaptation by creating a more certain environment for decisions on climate resilient development; and (iii) enabling actors with access to appropriate risk financing measures to remain in the tolerable risk space. One proposition is thus to embed climate insurance and other related instruments in a comprehensive climate

risk management approach accompanied by other risk reduction and management strategies in international cooperation programs and projects (Schäfer et al. 2018).

Proposition 5 *Policy deliberations have exhibited characteristics of a win-lose negotiation "game." A more inclusive narrative highlighting collective ambition, mutual benefits and the role of transformation can point a way forward.*

The L&D discourse has exhibited strong ethical and legal undertones appealing to standards shared or agreed beyond the UNFCCC context, such as demanding redistribution for harm via international customary law. While it is useful to prove the need for action on L&D by appealing to moral standards recognised by both contending parties in international arenas, a change of narrative may be conducive to achieving collective action and to avoid turning the issue into a win-lose negotiation "game" (chapter by Calliari et al. 2018).

With evidence that climate impacts and risks are also strongly affecting industrialised countries directly (e.g., Arctic) and indirectly (e.g., through migration), it may be fruitful to frame the debate in terms of the benefits that acting on adaptation and its possible limits and failures could bring for developed countries. Considerations could range from working towards more resilient global supply chains to gaining support for climate displacement and refugees. Exploring mutual gains would contribute to bolstering collective action on an issue of common concern, as well as to elevate and better integrate L&D into other climate negotiation agenda items, such as capacity building, technology and the global stocktake.

A general and joint entry point is the SDG agenda, essentially supporting UN member states' transformation around a set of global developmental goals. The SDGs, passed in 2015, constitute a universal set of 17 goals and 169 targets defining development aspiration and ideally, collective transformation for all signatory countries (UN 2015). The SDG debate casts an integrated and unifying perspective on development. Integrated—as it requires a synergistic look across these broad development goals, and unifying—as it involves all signatories (Dodds and Donoghue 2016). Risk is fundamental in many regards. There are down-side risks (disasters and climate-related impacts as at the heat of the L&D discourse), which are explicitly and implicitly mentioned in many of the SDGs. The need for and benefits of up-side risk taking through increased investment into the socio-economic development objectives is another one of the cross-cutting issues.

Transformative risk management, which, as we argue, should be one of the pillars of the L&D policy space, thus may be one of those issues of common concern (Schinko et al. 2018). Innovative polycentric science-society partnership models are springing up to support the implementation of transformative risk management options that manage critical disaster risks "on the ground". Evidence from hotspots, not only has potential to inform better development policies, but may also support actions in industrialised countries facing similar issues (Mechler et al. 2018b). The role of technology is crucial in this context, as it shapes risks and limits to adaptation and risk management. Yet, access in developing countries is constrained. National hydrological and meteorological services in developing countries, for example, are

limited in their possibilities to improve the spatial and temporal resolution of flood forecasts. This is because these countries lack the funding and capacity necessary to use state-of-the-art technology (i.e., computing power, advanced hydrological and meteorological models) and acquire or collect more granular data, such as digital-elevation-model data. In addition, the poor and the vulnerable can often not benefit from early warning/early action information due to the digital divide.

As an area of future work, progressive levels of innovation and technology are required to lead from incremental to transformative change, where the UNFCCC's Technology Mechanism can play a more prominent role (van den Homberg and McQuistan 2018). The WIM Executive Committee may innovatively consider an assessment of technologies from a climate justice perspective, which means rethinking access, use, innovation, finance, and (bottom-up) governance mechanisms from the perspective of the poor and vulnerable.

Enabling joint learning regarding technologies (and other means of implementation) for buffering against high-level risks is necessary for understanding how to overcome soft and avoid hard limits. This may be appealing for developed and developing countries sharing similar exposure and risk, where limits to adaptation need attention (e.g., in the Arctic, mountain areas with glacial retreat, etc.). A joint narrative will be needed to support and incentivise the requisite transformation of energy generation, consumption, but also adaptation efforts across the globe. An improved understanding of actual and potential "dangerous interference with the climate system" at risk management scales and across geographies may indeed be a decisive enabler.

1.6 Conclusions

The book has been a joint effort of the Loss and Damage Network that brings together scientists and practitioners from more than 40 institutions around the globe to inform the L&D debate. Offering a detailed overview of the multiple facets of knowledge emerging on the topic of L&D, the volume is a first comprehensive review of the state of play regarding the science, political debate, practice as well as any policy proposals seeing or looking for implementation. The WIM is now well into its 5-year work plan, and after COP23 in Bonn, the first climate summit chaired by a small island state (Fiji), the WIM stands to deliver on its various workstreams. In 2018, one focus is on the role of finance in supporting actions to address L&D, for which the so-called Suva expert dialogue was carried out in mid-2018 to project a way forward. This and other activities will inform the review of the WIM by the UNFCCC Parties during sessions of the subsidiary bodies in 2019, leading to proper review at COP25 in Rio. As we demonstrated, the science has matured, and interest in the issues is increasing. The IPCC has started to pick up on the discussion and considers L&D in its 1.5 °C report published in October 2018, in special reports on oceans and the cryosphere, and land, as well as in its 6th Assessment Report due in 2022.

Further work is to be done, ideally in close collaboration with policy advisors, negotiators, civil society, private- and public-sector representatives and, particularly, those vulnerable people and communities around the world that are actually and potentially affected by climate-related impacts and risks. The partners in the Loss and Damage Network stand ready to further contribute to the debate and help to identify actions to avert, address and minimise Loss&Damage.

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